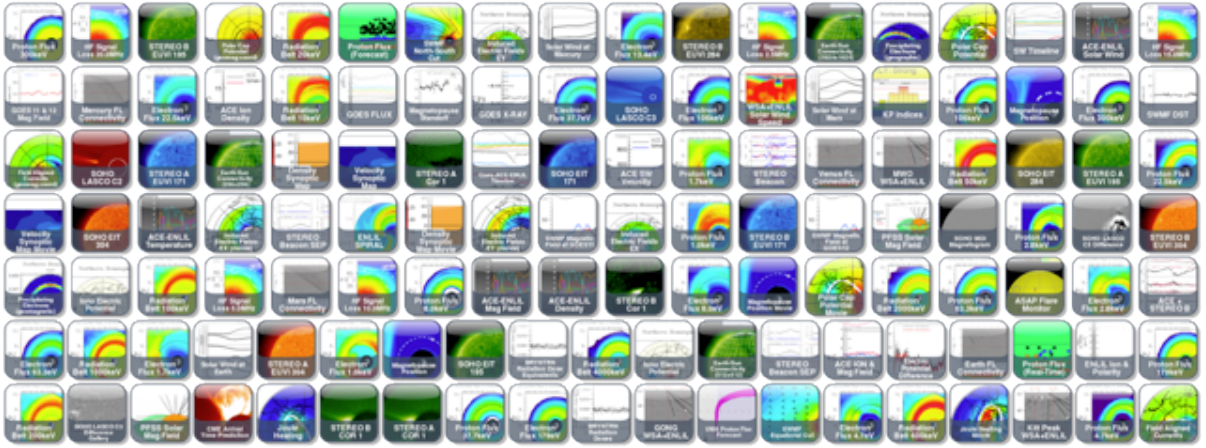
Monitoring Space Weather with iSWA

SWx Training 2020

Slides adapted from Yihua Zheng

Introduction
Monitoring Space Weather with iSWA

- iSWA — Integrated Space Weather Analysis System
- Allows forecasters to customize a space weather monitoring layout
- https://iswa.gsfc.nasa.gov



Introduction
iSWA Imagers

- SDO AIA for the earth facing solar surface
- SOHO LASCO coronagraphs for CMEs
- STEREO-A EUVI for far-sided solar surface
- STEREO-A coronagraphs
- Magnetic Connectivity Solarscape Viewer

https://www.nasa.gov/content/goddard/how-sdo-sees-the-sun

https://www.nasa.gov/mission_pages/sunearth/news/light-wavelengths.html

Introduction
iSWA Graphs/Timelines

- GOES (X-ray, Proton, & Electron Fluxes)
- SOHO/COSTEP Proton Flux (Real-time & Forecast)
- DSCOVR Solar Wind (Speed, Magnetic Field, Temperature, & Density)
- SWMF Magnetopause Standoff Position
- Kp (Observed & Predicted)
- STEREO Beacon (Solar Wind & SEPs)
- …and more!

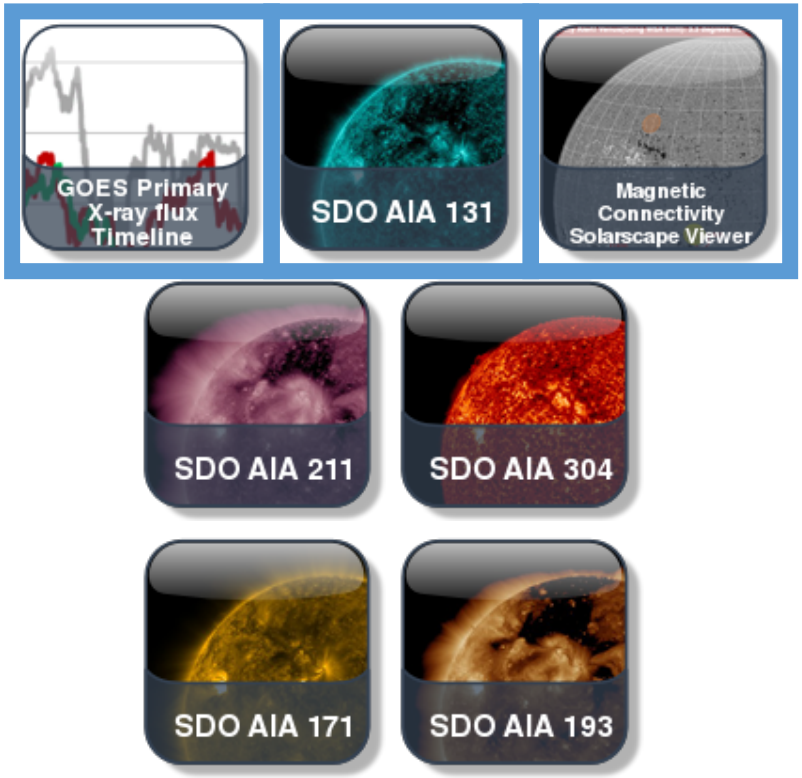
Super Timeline under 'bETA' tab

Outline

- Solar Cygnets
  - Monitoring flares, eruptions, & CMEs
- Heliosphere Cygnets
  - Monitoring solar energetic particles, CME arrivals, and high speed stream arrivals
- Magnetosphere Cygnets
  - Monitoring geomagnetic storms, radiation belt enhancements, and magnetopause crossings
- Demonstration
  - Following the course of the Sept 6, 2017 event.

Solar Cygnets: Solar Flares

- **GOES 0.1-0.8 nm X-rays — flares**
  - **Threshold: 5x10^{-5} W/m^2 (M5.0)**
- SDO AIA imagery — flares, eruptions, & coronal holes
  - 193 Å — 1 million Kelvin, EUV waves, dimming, post-eruption arcades, off limb (field lines), coronal holes
  - 171 Å — off limb (field lines), post-eruption arcades
  - **131 Å — flares (10 million Kelvin)**
  - 211 Å — 2 million Kelvin, active region (coronal holes)
  - 304 Å — 50K kelvin, filaments
- **Magnetic Connectivity Solarscape Viewer**
  - **SDO backgrounds, lat/lon grid, active region labels, and magnetic connectivity**



A strong flare can exhibit signatures in all wavelengths
e.g, the X9 class flare on 2017-09-06

Solar Cygnets: Eruptions & Coronal Holes

- GOES 0.1-0.8 nm X-rays — flares
  - Threshold: $5x10^{-5}$ W/m^2 (M5.0)
- SDO AIA imagery — flares, eruptions, & coronal holes
  - 193 Å — 1 million Kelvin, EUV waves, dimming, post-eruption arcades, off limb (field lines), coronal holes
  - 171 Å — off limb (field lines), post-eruption arcades
  - **131 Å — flares (10 million Kelvin)**
  - **211 Å** — 2 million Kelvin, active region (coronal holes)
  - 304 Å — 50K kelvin, filaments
- Magnetic Connectivity Solarscape Viewer
  - SDO backgrounds, lat/lon grid, active region labels, and magnetic connectivity

Solar Cygnets: Coronal Mass Ejections (CMEs)

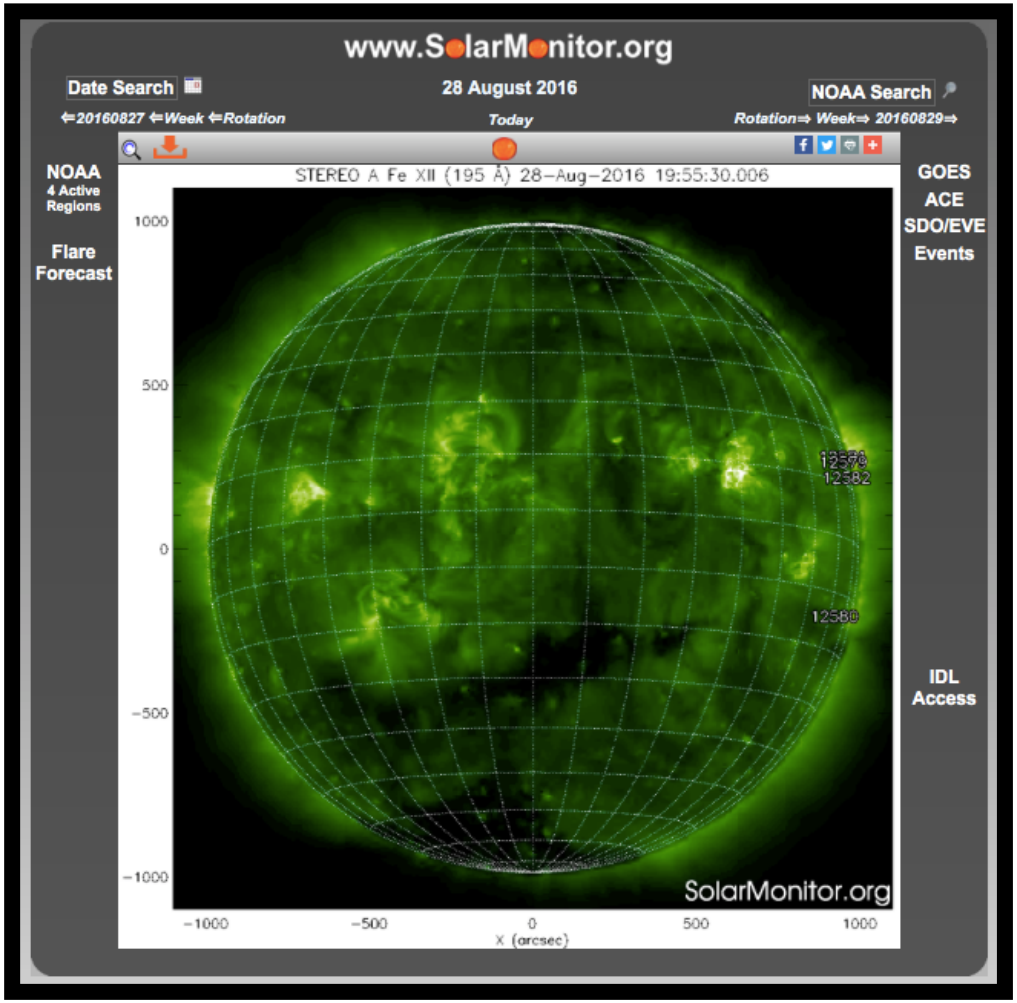
- SOHO LASCO C2 & 3 imagery
  - CMEs
    - C2 — 1.5 to 6 solar radii
    - C3 — 3.7 to ~30 solar radii
    - Threshold: measured >=500 km/s and modeled to impact Earth OR measured >= 800 km/s and modeled to impact other location
    - **Any CME heading towards Parker Solar Probe**

Solar Cygnets: STEREO-A

- STEREO A EUVI 195 Å imagery — flares, eruptions, & coronal holes
- STEREO A COR2 imagery — CMEs
  - Up to 15 solar radii
    - **Threshold: measured >=500 km/s and modeled to impact Earth OR measured >= 800 km/s and modeled to impact other location**
    - **Any CME heading towards Parker Solar Probe**

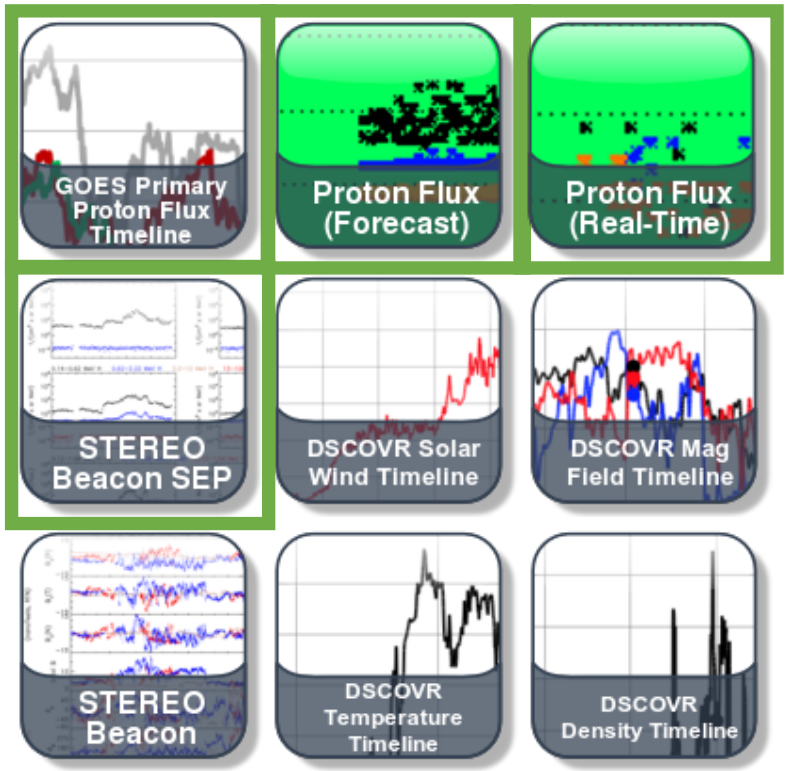
Solar Cygnets: STEREO-A

- www.SolarMonitor.org (not on iSWA)
  - lat/lon grid and active regions



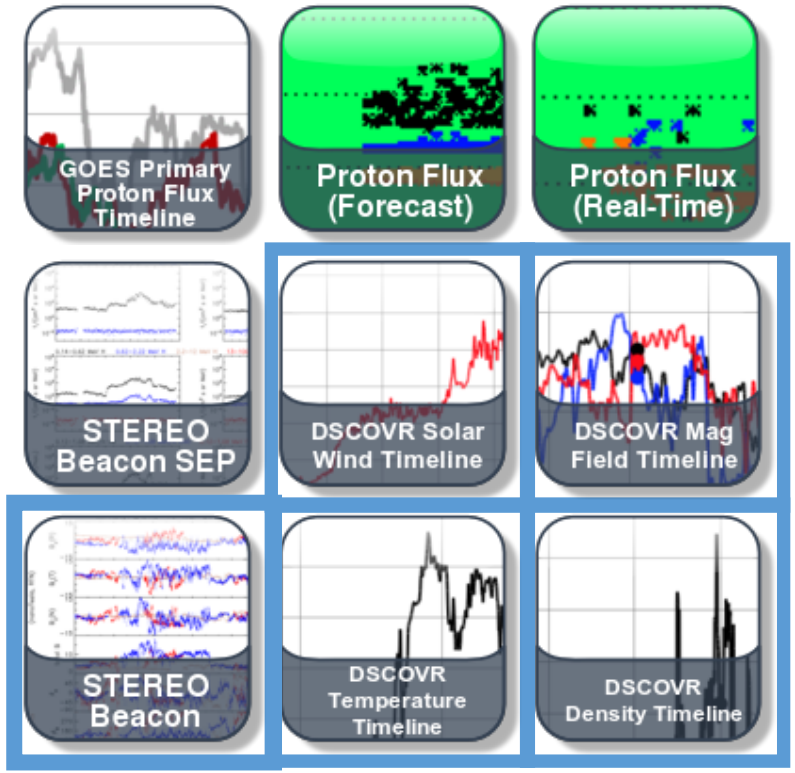
Heliosphere Cygnets: Solar Energetic Particles

- GOES > 10 MeV and > 100 MeV protons
  - Threshold: > 10 MeV above 10 pfu and/or > 100 MeV above 1 pfu
- SOHO COSTEP > 15.8 MeV proton channels
  - Threshold: 10^(-1) pfu/MeV
- RELEASE forecast for > 15.8 MeV proton channels
  - Threshold: 10^(-1) pfu/MeV
- STEREO A and B 13-100 MeV protons
  - Threshold: 10^(-1) pfu/MeV



Heliosphere Cygnets: Interplanetary Shocks/Arrivals

- DSCOVR/ACE
  - speed, magnetic field, temperature, & density
  - Threshold: significant shock passage at L1 (about >=10 nT amplitude jump)
- STEREO A IMPACT/PLASTIC
  - speed, magnetic field, temperature, & density

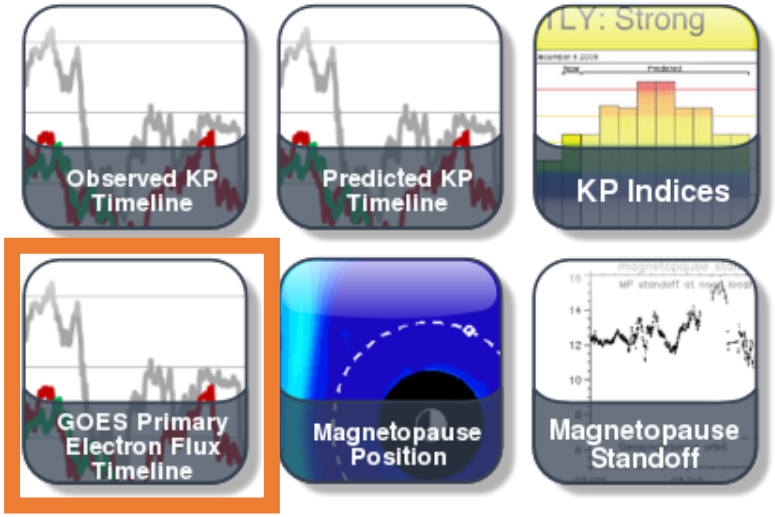


Magnetosphere Cygnets: Geomagnetic Storms

- Kp index
  - level (0 to 9) of geomagnetic activity in the Earth's magnetosphere
  - Threshold: >=6 (or larger than previous alert)

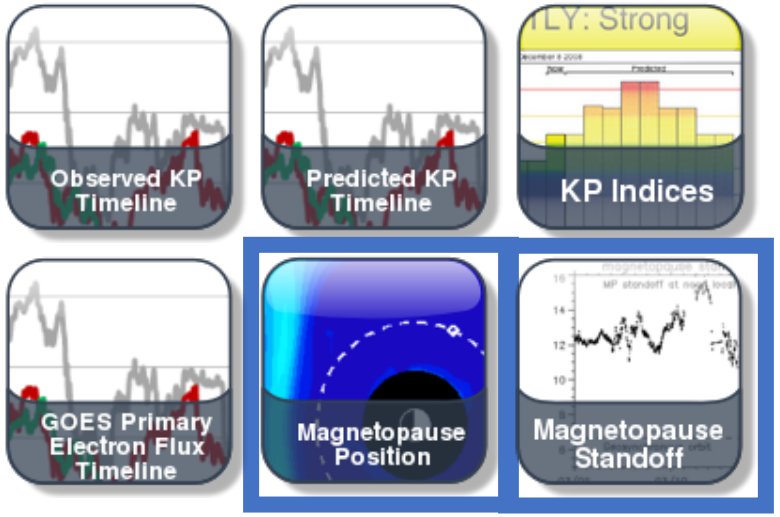
Magnetosphere Cygnets: Radiation Belt Enhancement

- GOES > 0.8 MeV electrons
  - state of the Earth's outer radiation belt
  - Threshold: 10^5 pfu (or 70-80 % from the threshold two days after)



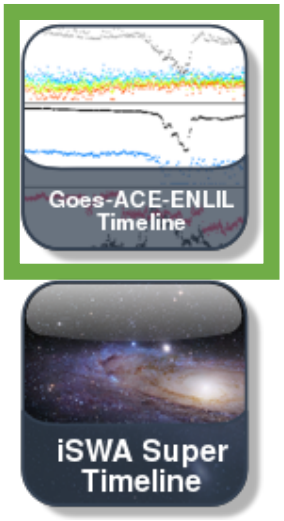
Magnetosphere Cygnets: Magnetopause Crossing

- Modeled magnetopause standoff distance
  - location of the boundary between magnetospheric and solar wind plasma
  - Threshold: 6.6 Re



Other Useful Cygnets

- CCMC SWAN Space Weather Timeline Ensemble
  - Quick check of flare, SEP, radiation belt, and solar wind conditions



Other Useful Cygnets

- iSWA Super Timeline
  - Make interactive plots of static cygnets
  - Plot SWMF Magnetopause Standoff Position with geosynchronous orbit
  - Plot CCMC-Predicted Kp with NOAA-Kp